

REMARKS

In view of the above amendments and following remarks, reconsideration of the objections and rejections contained in the Office Action of June 5, 2003 is respectfully requested.

Initially, it is noted that a number of minor editorial corrections have been made to the specification and abstract to generally improve the form of the present application and so as to remedy the matters raised by the Examiner in section 6 on page 2 of the Office Action.

The Examiner's attention is further directed to the enclose Notice Re Proposed Drawing Amendments proposing correction of Figs. 3D, 25 and 29A-E and 30. These corrections address the matters raised by the Examiner in sections 2-5 on page 2 of the Office Action. With respect to Fig. 25, it is noted that the reference sign has been proposed to be removed from Fig. 25. The Examiner is thanked for his careful review of the drawings and specification.

By the above amendments, original claims 6-81 have been canceled in view of the restriction requirement. Elected claims 1-4 remain. New claims 82-85 also correspond to the elected invention. Claim 5 was non-elected, but in view of the above amendments, it is respectfully submitted that claim 5 should be considered for inclusion with claims 1-4 and 82-85.

The Examiner rejected claims 1 and 3 as being unpatentable over Sakaki, U.S. 6,454,918 (Sakaki) in view of Woodruff et al., U.S. 6,309,524 (Woodruff) and Belongia, U.S. 6,391,209 (Belongia). Further, claims 2 and 4 were rejected as being unpatentable over Sakaki, Woodruff, Belongia and in further view of Uzoh et al., U.S. 6,113,769 (Uzoh). However, it is respectfully submitted that the present invention, particularly as now amended above, clearly distinguishes over all of these references.

Noting for example Figs. 1-2, a plating apparatus according to the invention has a cation exchange membrane 318 used as a diaphragm disposed between a cathode, i.e. the substrate, and an anode 312 connected to a plating power source 313. The diaphragm 318 partitions the space in plating tank 311 into two regions T₁, including the substrate, and T₂, including the anode 312. As noted, a neutral porous diaphragm capable of removing small particles in place of the cation exchange membrane 318 could be used.

A first plating liquid circulation system C_1 circulates plating liquid Q from into region T_1 . A second plating liquid circulation system T_2 circulates plating liquid Q from into region T_2 . Either one or both of the circulation systems includes a deaerator, such as deaerator 328, for removing dissolved gases from the plating liquid Q. As noted on page 18 of the specification, it is desirable to maintain the concentration of dissolved oxygen between approximately $1\text{ }\mu\text{g/l}$ (1 ppb) and 4 mg/l (4 ppm). With this concentration, it is possible to eliminate bubbles dissolved in the plating liquid nearly to zero, thereby forming a satisfactory plated film.

Independent claim 1 has been amended to recite that the deaerator is for deaerating to maintain a concentration of dissolved oxygen in the plating liquid between $1\text{ }\mu\text{g/l}$ and 4 mg/l . None of the references cited by the Examiner disclose or suggest a deaerating unit having this capability.

As the Examiner notes, Sakaki does not disclose a deaerating unit in at least one of the plating liquids circulating systems. However, the Examiner cites Belongia for disclosing a degasser.

However, Belongia does not disclose or suggest a degasser having the above capability. As the Examiner notes, Belongia states that “gas removal may be in the form of a simple degasser such as a membrane device with a vacuum on the side of the membrane opposite the fluid. Gas is simply pulled through the membrane and disposed of in a proper manner.” However, there is no disclosure or suggestion of the capabilities required by independent claim 1 as now amended. For this reason, the references cited by the Examiner do not disclose or suggest independent claim 1.

New claims 82-85 have been presented for the sake of a slightly different scope of protection. However, such claims distinguish over the references cited by the Examiner for the same reasons as discussed above, as becomes clear from a review of independent 82.

While independent claim 5 was withdrawn by the Examiner as being non-elected, it is noted that independent claim 5 is directed to a plating method in which the concentration of dissolved oxygen and the plating liquid is maintained between $1\text{ }\mu\text{g/l}$ and 4 mg/l by a deaerating unit. Because of the similarity of the limitation in this claim and claims 1 and 82, it is respectfully submitted that it would be appropriate to re-consider claim 5 along with the elected claims. Accordingly, such withdrawal of the restriction requirement, to the extent it is applicable to claim 5, is requested.

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance, and the Examiner is requested to pass the case to issue. If the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact Applicants' undersigned representative.

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

~~There is provided an~~ An apparatus ~~suited for forming forms~~ a plated film in fine trenches and plugs for interconnects; and in the openings of a resist formed in the surface of a substrate such as a semiconductor wafer, and ~~for forming forms~~ bumps (protruding electrodes) on the surface of a semiconductor wafer. The apparatus includes a substrate holder capable of opening and closing for holding a substrate such that the front surface of the substrate is exposed while the backside and the edge thereof are hermetically sealed; ~~a.~~ A plating tank ~~accommodating~~ accommodates a plating liquid in which an anode is immersed; ~~a.~~ A diaphragm is provided in the plating tank and disposed between the anode and the substrate held by the substrate holder; ~~plating.~~ Plating liquid circulating systems ~~for circulating~~ circulate the plating liquid to ~~the~~ respective regions of the plating tank, separated by the diaphragm; ~~and a.~~ A deaerating unit is disposed in at least one of the plating liquid circulating systems.